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**SITE CONTAMINATION CLEANUP  
APPORTIONMENT EVALUATION**

**PREPARED FOR  
CLAPP & EISENBERG**

**REGARDING:  
THE FROLA PROPERTY  
163 RIVER ROAD  
EDGEWATER, NEW JERSEY**

**JANUARY 1994**

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## **1.0 INTRODUCTION**

### **1.1 General**

The Frola property is approximately 8 acres in size and is situated on the west bank of the Hudson River in Edgewater, New Jersey. The Allied Chemical Corporation (Allied) operated a coal tar processing plant at this location from approximately 1918 to 1971. The property was sold to James V. Frola in March 1974; Albert Von Dohln later became a part owner with Mr. Frola. Subsequently, the property was leased, at various times, to companies engaged in the business of waste oil storage and recycling.

Operations ceased at the site in July 1981, at the direction of the New Jersey Department of Environmental Protection (NJDEP). A surface cleanup was initiated in April 1985 via a United States Environmental Protection Agency (EPA) Emergency Removal Action. In November 1985, Allied, representing a group of 62 Potential Responsible Parties (PRPs), accepted responsibility for the on-going surface cleanup.

Paulus Sokolowski and Sartor, Inc. (PS&S) was requested by Clapp & Eisenberg, counsel for the estate of James V. Frola and Alfred Von Dohln to provide an opinion, based upon existing information as to whether or not an apportionment of responsibility for subsurface site remediation among Allied and the subsequent waste oil storage and recycling businesses is possible and, if possible, to what extent responsibility may be attributable to each of the two operations.

### **1.2 Evaluation of Apportionment Responsibility**

PS&S has reviewed available documents describing historical site ownership, site activities, hazardous materials usage and management, and limited environmental analytical data. This data has been used to document, to the degree practicable, an opinion as to the apportionment of subsurface cleanup responsibility. Evaluation criteria included the following:

- Contamination Documentation
- Duration of Site Usage
- Areas of Use
- Nature of Site Usage
- Exclusive Use of Chemicals

A review of each of these relevant factors is contained in the following sections of this review.

## **2.0 SITE USAGE**

### **2.1 Allied Chemical Co.**

Allied owned and operated a coal tar distillation and creosote terminal facility on the subject site for approximately 53 years. According to Allied documents, the Edgewater plant was started in 1918 and was shut down in May 1971 "due to naphthalene price deterioration and creosote market considerations" (E.J. Korbel, 5/20/74). Plans were made to utilize the location as a creosote terminal after manufacturing operations were discontinued, but it does not appear that this option was implemented.

Aerial photographs and site plans indicate that the entire site was utilized by Allied for its operations. Site usage was apparently significant throughout their occupation of the site, as documented below:

- A review of a 4/6/40 aerial photograph of the site indicates the presence of approximately 68 above ground storage tanks (ASTs). These tanks were located throughout the facility. Several barges were also observed along the dock and piers on the Hudson River.
- A 6/1/64 Allied site plan shows the location of 79 ASTs. At the time of the EPA Immediate Removal Action, the site contained 61 above-ground storage tanks with a storage capacity of approximately 9 million gallons (USEPA, 3/81).
- The USEPA (3/1/81) reported 1,573,861 gallons of coal tar-associated materials removed from the site by Allied from 3/26/86 through 8/03/88.

Products listed on a 12/7/70 inventory included creosote distillate, shingle stain oil, refined coal tar, various pitches, thinners, primers, and enamels.

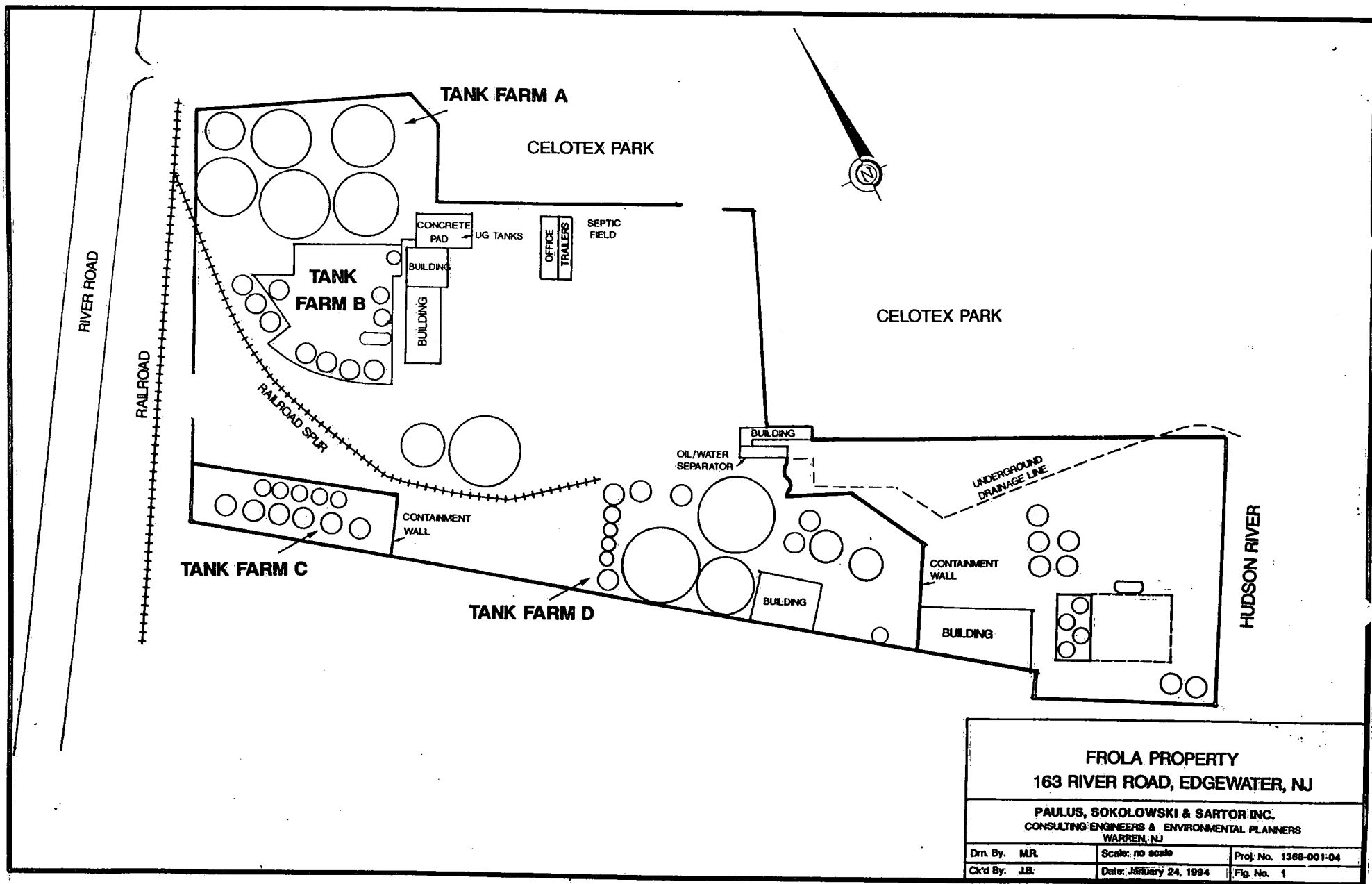
## **2.2 Waste Oil Recyclers**

Allied sold the property to James V. Frola on March 18, 1974; Albert Von Dohln later became a part owner with Mr. Frola. A series of waste oil recycling companies then leased, at different times, all or portions of the property from October 14, 1974 through July 1981, a period of approximately 7 years.

Gaess Environmental Service Corp (GES) leased 11 tanks on the southeast corner of the site from October 15, 1974 to October 15, 1975. (GES was apparently utilizing these tanks for oil storage at the time of the property purchase by Mr. Frola in 1974.) On May 13, 1977 the Dublin Equipment Corporation signed a five-year lease and Energy Recovery Procedures Corporation (ERP) was designated as tenant. On July 14, 1978, ERP assigned its lease to Edgewater Terminals, Inc. and on July 15, 1980, Edgewater Terminals assigned its lease to Quanta Resources Corp.

Operations ceased at the site in July 1981, at the direction of the NJDEP, which subsequently issued a formal order to cease operations in October 1981. Quanta Resources Corporation filed for reorganization as per Chapter 11 of the Bankruptcy code and, in November 1981, the Chapter 11 Petition was converted into a Chapter 7 liquidation.

The northwest portion of the site was apparently the main operational area. Waste oil was brought onto the site and stored in tanks in this area and processed in the main building adjoining tank farm B (see Figure 1). However, available records indicate that portions of the four major tank farms (Tank Farm A, B, C, and D) were all utilized for the storage of petroleum-based materials.



### **3.0 HAZARDOUS MATERIALS USAGE**

Review of available data indicates that Allied was the sole on-site user and processor of coal tar and coal tar-processed materials.

Petroleum hydrocarbon materials were utilized by both Allied and the subsequent waste oil processors. Fuel oils were known to be stored in ASTS in Tank Farm "D" by Allied and were presumably used in the boiler house. However, in a 50-year history of operations, petroleum products could have been handled in many areas - truck and train deliveries, processing tanks, and in vehicles of all kinds.

Waste oils and/or the processed oils were apparently used in all of the major tank farms (A,B,C & D) by one or more of the subsequent waste oil processors, as well.

## **4.0 HAZARDOUS MATERIALS MANAGEMENT**

### **4.1 Allied Chemical Co.**

Numerous material spills, explosions and other on-site environmental incidents have been documented during Allied's ownership and operation in the late 1960's and early 1970's. Spill containment and treatment facilities were apparently insufficient to mitigate the environmental effects of these incidents. The following incidents were documented in Allied correspondence relating to this facility.

On July 31, 1968 an explosion and resultant fire occurred at the #3 Pitch receiver. Approximately 8,000 gallons of hot pitch (660° F) spilled. The cause was presumed to be due to a rapid pressure increase due to addition of water to the hot pitch (H.J. Goebbert, et al., 8/6/68).

A spill of an undocumented volume of carbolic oil occurred on December 31, 1969 (R.L. Fawcett, 1/15/70).

Three thousand gallons of creosote oil spilled into the site storm sewer and entered the Hudson River on January 5, 1970.

A property loss prevention report by Marsh & McLennon dated September 16, 1970 noted that "Tank #29 was destroyed in a fire (Feb. 1970) caused by an oil leak on a tank car that was ignited by a propane torch during unloading operations. The fire spread to the tank supports which buckled due to the heat".

Notes of R.B. Rosener to B.T. McMillan (4/24/70) indicated that housekeeping standards "had slipped considerably" during the winter. In addition, water and ground oils from the northwest tank farm had laid stagnant on the ground and had overflowed on streets. Leak control was noted as only fair and an abatement program was in progress "trying to reverse 65 years of bad habits". May 26, 1970 correspondence from B.T. McMillan indicated that funding for curbing and sewer lines to provide a more long term solution to this problem had not been approved.

Allied documents indicated that major water and air pollution control violations had also occurred at the facility and that significant environmental issues needed to be addressed in the years immediately prior to the cessation of Allied operations. These included the following:



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R.L. Fawcett (3/20/70) noted that an NJDEP consent order dated February 7, 1969 required Allied to implement an air pollution abatement program, with compliance due July 1, 1969. In addition, it was noted that "odors from 30 Series and Fibre Coolers remain excessive and state will start receiving specific complaints this spring and summer unless abatement is effected". A.J. Frank (3/26/70) described the history of air pollution abatement (particularly odors) as "dismal", with state files as old as 10-15 years.

January 15, 1970 correspondence from R.L. Fawcett noted that "enforcement actions have materialized and abatement of oils and phenols (BOD) will be required, apparently this year". Included in the anticipated requirements were installation of spill protection facilities including the dock area, emergency containment and pumping of the save all contents, and drainage of all tank areas to the separator. It was also noted that to produce "an effluent quality of the residual drainage from process areas satisfactory to the State a significant improvement in plant operations re control of oil spills, leaks, losses to and through the oil-water separator will be required".

Draft correspondence from B.T. McMillan (4/29/70) noted that Allied was charged by the State of New Jersey for discharging industrial wastes and other polluting matter into the Hudson River in violation of R.S. 58:12-2 and with violation of Chapter 6 Section 2.1 of the New Jersey Air Pollution Control code relating to nuisance odor complaints in the neighborhood above the plant.

In an April 24, 1970 correspondence, B.T. McMillan observed that "there is attendant plant problem with operational, maintenance and housekeeping performance that directly affects plant's capacity to meet regulatory control requirements and enforcement. Until this is reversed, I doubt that the plant will effectively meet regulatory requirements". In an additional April 20, 1970 correspondence, preliminary process wastewater characteristics for COD (22,000 ppm), BOD (12,300 ppm) and phenols (5,400 ppm) were noted.

A November 19, 1970 memorandum from R.B. Rosener stated that a complaint concerning odors was received from a resident of North Bergen that night. As a result, the blend tank was not to be used without his permission.

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#### 4.2 Waste Oil Recyclers

Concerns regarding environmental and health conditions at the site were also documented after the sale of the property to Mr. Frola.

The U.S. Coast Guard (USCG) monitored the site from 1979 through 1981. Reports documenting these visits noted the need to maintain a containment boom and sorbent placed along the Hudson River waterfront to prevent oil from entering the river. A USCG report documented a "pollution incident" on January 12, 1979. The report noted that oil extended from just north of Newtown Refinery 1/8 mile south of Lever Brothers and that approximately 75-100 gallons of oil had escaped from the containment boom.

The NJDEP, Bureau of Hazardous Waste, also documented numerous inspections of the facility in 1980 and 1981. Housekeeping problems was the primary complaint noted by NJDEP. Site inspection reports noted numerous releases from tanks, lines and vehicles on-site and cleanup actions being undertaken. These reports documented the spillage of petroleum products in the areas of Tank farms A, B, C, and D at one time or another.

A report dated 3/12/81 noted that oil and oily sludges covered an area approximately 20' x 50' in Tank Farm "A". A report dated 5/4/81 noted that pools of oil, and oil and standing water covered areas approximately 100' x 15' and 25' x 15' in the south section of Tank Farm "A". This was attributed to the overflow of tank B-12.

An August 10, 1977 memorandum by A. Davies of Allied described a visit to the site by Mr. Davies and Mr. Rosener and Mr. Pat Job of ERP. Mr. Davies noted that "there were a number of potentially hazardous situations in the environmental and industrial areas". His observations included:

The "SAV-ALL" was very oily and there was the potential for this oil to make its way to the Hudson River. The oil did not appear to be coal tar oil.

The former solvent tank farm was very oily and although diked, there was a hole in the dike about a foot from the bottom which allowed oil to run out onto the adjacent land.

The boiler house floor was covered with an oil spill.

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The barrelling dock was covered with tar as a result of some drums of tar which had rusted and run over the dock.

There were a number of areas where oil was lying on the ground and could be carried to the river in the event of a heavy rainstorm.

It was noted that ERP had cleaned 18 tanks to date. Mr. Coari, the former Superintendent of Operations at the Edgewater Plant also had talked to Mr. Job about safety aspects of handling coal tar products.

## 5.0 CONTAMINATION DOCUMENTATION

Two episodes of soil sampling and analysis are known to have been conducted on the site. No groundwater data is known to be available. In May 1990, PS&S collected eleven (11) soil samples from a total of eight soil borings for chemical analysis of USEPA Priority Pollutants (PP+40) and total petroleum hydrocarbons (TPHC). Eight samples were collected from 8 borings within the 0.0 to 3.0 foot depth interval. Three additional soil samples were obtained from three of those borings within the 4.0 to 6.0 foot depth interval. Those samples were analyzed by Accutest, an NJDEP-certified laboratory.

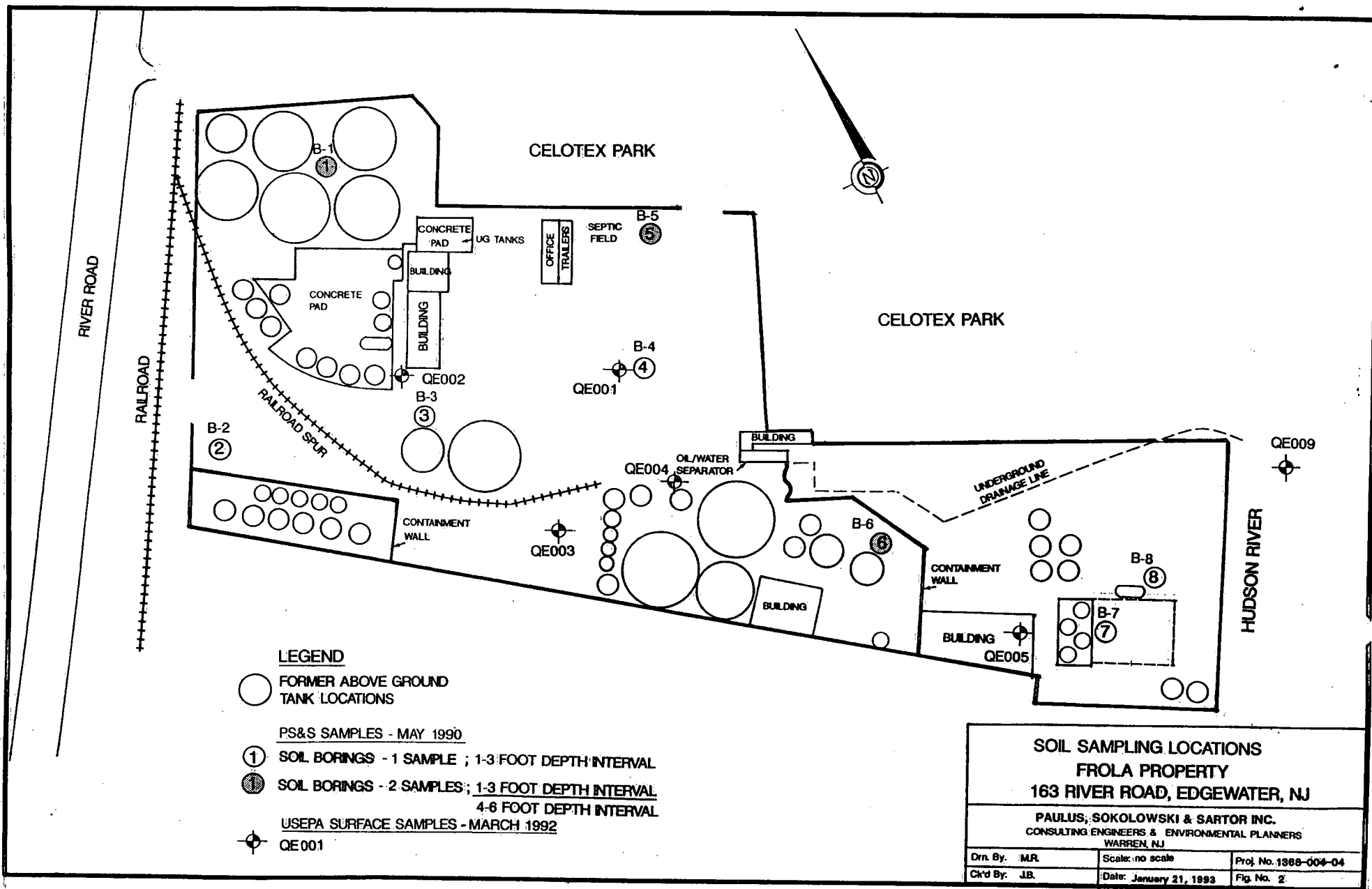
A second set of environmental samples was obtained by Roy F. Weston, a USEPA contractor, on March 26, 1992. Five soil samples were obtained from various areas of the site. Locations of soil samples obtained as part of both investigations are depicted on Figure 2. Summaries of the analytical data are included in Appendix A.

Available analytical data indicates that concentrations of individual base neutral (BN) organic compounds are present throughout the site in concentrations of 100 to 1,000 times the NJDEPE March 1993 cleanup criteria. Examples of BN compound concentrations in parts per million (ppm) reported in site soils exceeding NJDEPE non-residential direct contact cleanup criteria and the number of samples in which NJDEPE non-residential cleanup criteria were exceeded are listed below. (Sixteen soil sample analyses were available for review).

<u>BN Compound</u>	<u>Concentration Range</u>	<u>No. of Values</u>	<u>NJDEPE Non-Residential Cleanup Criteria</u>
Benzo(a)pyrene	14 - 1100	13	0.66 ppm
Benzo(k)fluoranthene	13 - 320	9	4.0 ppm
Benzo(a)anthracene	20 - 1100	12	4.0 ppm

Numerous additional analyses appeared to exceed the current NJDEPE cleanup criteria for these parameters, but because of the relatively high detection limits (usually associated with more highly contaminated samples), those concentrations were estimated and were not included in this summary.

TPHC concentrations also exceeded NJDEPE cleanup criteria in individual locations on the site. TPHC concentrations are included in the evaluation of total organic compounds and the NJDEPE cleanup criteria for total organic compounds is 10,000 ppm. TPHC concentrations exceeding 10,000 ppm were reported in seven of the sixteen soil samples collected from the site. Concentrations of these values ranged from 1,200 to



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38,000 ppm. However, there is a potential for these values to be artificially inflated due to interferences from elevated levels of BN compounds interfering in the analytical procedures. Potential interferences can (now) be removed through the use supplementary laboratory sample preparation procedures.

A summary of the BN and TPHC concentrations reported through both of the above-noted sampling programs, together with an evaluation of the apparent source of the reported contamination as evaluated by Dr. Elliot are presented and discussed in section 6.0.

## **6.0 CONTAMINATION SOURCE MATERIALS**

The primary contaminants documented in the on-site fill involve base-neutral organic compounds (BNs) and total petroleum hydrocarbons (TPHCs). Volatile organic compounds have also been reported in specific areas of the site. The primary sources of these contaminants are presumed to be coal-tar materials and petroleum products (i.e., fuel oil, and waste oil).

Before reviewing the analytical results and their interpretation, in terms of the probable source of the contamination, the basic chemical differences between coal- and petroleum-derived materials should be reviewed. The following review of these materials was supplied by Dr. James J. Elliot. Reports by Dr. Elliot are included in Appendix B.

"There are, in general, major compositional differences between coal- and petroleum-derived fluids, caused partly by the very different chemical composition of the raw materials; coal or petroleum; and partly by the processes by which the fluids are formed; thermal decomposition or distillation.

Coal is an organic solid, containing predominantly the element carbon, along with high concentrations of the elements hydrogen, oxygen, nitrogen and, to a lesser degree, sulfur. Coal also contains mineral matter, frequently including the mineral iron sulfide. When coal is pyrolysed; heated; it decomposes to form gases, coal tars and coke. The tars are very aromatic in composition [contain organic compounds classified as "aromatics"]. They are rich in naphthalenes in particular, along with anthracenes and other polynuclears. They are also rich in phenolics, which contain much of the original oxygen, and nitrogen heterocyclics such as pyridines and quinolines. The initially-formed tars can be distilled into light naphthas; very rich in benzene, toluene and xylenes; into creosotes; rich in naphthalines; into anthracene oils and into residue pitch. The phenolics and nitrogen-containing compounds are frequently removed from the tars because of their value as chemicals. The various cuts can be treated in various ways to improve their properties for a given usage; heat-soaked, air-blown, etc., but the basic, highly aromatic nature of the products remains unchanged.

Petroleum, on the other hand, is essentially a liquid; rich in carbon, to a lesser degree in hydrogen, but low in nitrogen and very low in oxygen. Products are initially produced primarily by distillation and are rich in the compound types called paraffins and cycloparaffins (naphthenes) rather than aromatics. Petroleum products do contain aromatics, but they are more likely to be combined with naphthenes than to be bare or lightly-substituted as in coal-derived products. Thus, a major way of determining the probable source of a given "oily material" is to look at the aromaticity, both amount and type, and to look particularly at the naphthalene content. It should be noted that "naphthalenes" and "naphthenes" are quite different materials despite the unfortunate similarity in names.

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A second way to determine probable origin is to compare the numbers obtained by the analyses for TPH and TBN, two separate analytical procedures. In a way, this is also a measure of aromaticity. In essence, petroleum-derived material will tend to give high TPH and low TBN, whereas coal tars will tend to give TBN's that are higher than the TPH value.

There are other "markers" that can be looked for, in themselves not necessarily definitive, but in combination can provide supportive information. One marker is the phenolic content, often high in coal tars, always low in petroleum. Benzofurans are often found in coal tars, rarely to a significant extent in petroleum. Petroleum is rich in paraffins and cycloparaffins (naphthenes), coal tars are always low."

The BN compounds reported at the site are primarily comprised of polynuclear aromatic hydrocarbons (PNAs). "PNA's have been reported in some used lubricating oils, but only at a few parts per million in the oil. The levels of PNA's in the soil from the Frola property are in the 100's and 1000's ppm and the only source for such levels are coal-derived fluids" (J.J. Elliot, 1/20/94).



**7.0 APPORTIONMENT RECOMMENDATION**

The primary criteria for evaluating the apportionment of responsibility for subsurface cleanup of the Frola site were as follows:

- Use of chemical or materials contributing to reported contamination;
- Spills, releases or discharges which would contribute to the presence or distribution of contamination;
- Location(s) of site operations; and
- Site Usage

A summary of the relevant findings pertinent to these criteria are summarized below:

1) Use of Chemicals or Materials

Concentrations of individual PNAs have been reported which exceed current NJDEPE direct contact non-residential cleanup criteria for soils. Coal tar materials are considered the primary source of the elevated concentrations of PNA's documented throughout site soils. Allied was the sole identified user of coal tar materials at the site.

TPHCs have also been reported in site soils in concentrations which also exceed current NJDEPE cleanup guidelines. The primary materials which would contribute to elevated concentrations of TPHCs would be petroleum products stored, processed or utilized on the site. Petroleum products were utilized by both Allied (fuel oils) and the subsequent waste oil recyclers (waste and re-processed oils).

2) Records of Spillage, Leaks, etc.

Spills of hazardous materials which could have contributed to site contamination were documented during site usage by both Allied and the subsequent waste oil processors. The contribution of such releases, as documented by available records, appeared to be significant. However relative contributions by the two groups could not be estimated and the criteria was not utilized to further apportion responsibility for site cleanup.

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3) **Location of Site Operations**

Allied utilized the entire site during its years of operation. While the subsequent waste oil recyclers primarily utilized the northwest corner of the property, sufficient records were available to document their use of tanks throughout the site. Since both groups used the entire site (to some degree), responsibility for site cleanup based upon delineation of site usage was not feasible.

4) **Site Usage**

Allied utilized the entire site for 53 years, the subsequent waste oil recyclers, approximately seven years.

Based upon the review of available analytical data and other information, it is apparent that both Allied and the waste oil recyclers utilized hazardous materials throughout the site which contributed or may have contributed to the contamination reported in site soils. In addition, records of spills and other environmental incidents involving the subject hazardous materials have been amply documented during both Allied's and the waste oil recyclers' occupation of the property.

Available information indicates that Allied utilized coal tar materials during its 50-year occupation of the site. These materials are primary sources of base neutral organic compound contamination. Base neutral compound contamination levels are significantly above current NJDEPE cleanup criteria and their occurrence is widespread. In addition, both Allied and the waste oil recyclers utilized petroleum products which could have contributed to site contamination. However, the relative contribution to site contamination from petroleum-based materials utilized by Allied and the subsequent waste oil recyclers could not be estimated, limiting the feasibility of apportioning site cleanup based strictly upon materials used which are related to reported contamination.

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Therefore, it is recommended that cleanup responsibility could most equitably be apportioned based upon relative length of time operations were conducted at the site by Allied (53 years) and the waste oil recyclers (7 years). It is the opinion of PS&S that responsibility for subsurface cleanup should be apportioned as follows:

Allied Chemical Co. - 88%

Waste Oil Recyclers - 12%

It should be noted that this apportionment recommendation is based upon information available to PS&S and that additional information, including groundwater quality data, may be sufficient for re-evaluation of this recommendation.

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**APPENDIX A**  
**SUMMARY OF SITE SOIL CHEMICAL ANALYSES**

TABLE 2  
FROLA PROPERTY  
Summary of Laboratory Analytical Data - Accutest  
Volatile Organic Compound Analysis of Soils  
May, 1990

Sample No.	B1-AS1	B1-AS2	B2-AS1	B3-AS1	B4-AS1	B5-AS1	B5-AS2
Depth (ft)	1-3.0'	4-6.0'	1-3.0'	1-3.0'	1-3.0'	1-3.0'	4-6.0'
Sample Type	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL
Date	5/21/90	5/21/90	5/21/90	5/21/90	5/21/90	5/21/90	5/21/90
BENZENE	0.72	0.11	ND	4.6	ND	ND	ND
ETHYLBENZENE	11	1.5	4.1	20	ND	ND	ND
TOLUENE	5.1	0.95	ND	6.7	ND	ND	ND
TRICHLOROETHYLENE	ND	ND	ND	ND	ND	ND	ND
m-XYLENE	19	2.8	3.7	3.8	0.14	ND	ND
p,o-XYLENE	18	2.7	26	33	0.35	ND	ND
	-----	-----	-----	-----	-----	-----	-----
TOTAL VOLATILE ORGANICS	53.82	8.06	33.8	68.1	.49	ND	ND
TOTAL TI VOLATILE ORGANICS	314.3	35.16	1,326.2	223.9	3.8	2.3	.03

All results reported in Parts Per Million (PPM)

TI: Tentatively Identified

ND: Not Detected At Method Detection Limit

NJDEP ECRA Priority Pollutant VOC Guideline = 1.0 ppm

TABLE 2 (con't)  
 FROLA PROPERTY  
 Summary of Laboratory Analytical Data - Accutest  
 Volatile Organic Compound Analysis of Soils  
 May, 1990

Sample No.	B6-AS1	B6-AS2	B7-AS1	B8-AS1	FB-1	FB-2	TB-1
Depth (ft)	4.5-5.0'	0.0-0.5'	0.0-0.5'	0.0-0.5'	--	--	--
Sample Type	SOIL	SOIL	SOIL	SOIL	WATER	WATER	WATER
Date	5/22/90	5/22/90	5/22/90	5/22/90	5/21/90	5/22/90	5/21/90
BENZENE	8.1	19	11	0.09	ND	ND	ND
ETHYLBENZENE	38	50	9.4	2.5	ND	ND	ND
TOLUENE	25	42	31	0.17	ND	ND	ND
TRICHLOROETHYLENE	ND	ND	ND	0.54	ND	ND	ND
m-XYLENE	37	45	25	0.48	ND	ND	ND
p,o-XYLENE	41	49	29	1.6	ND	ND	ND
	-----	-----	-----	-----	-----	-----	-----
TOTAL VOLATILE ORGANICS	149.1	205	105.4	5.38	ND	ND	ND
TOTAL TI VOLATILE ORGANICS	285	839	148.9	8.88	ND	ND	ND

All results reported in Parts Per Million (PPM)

TI: Tentatively Identified

ND: Not Detected At Method Detection Limit

NJDEP ECRA Priority Pollutant VOC Guideline = 1.0 ppm

TABLE 3  
FROLA PROPERTY  
Summary Of Library Search  
Volatile Organic Compounds in Soils  
May, 1990

Sample No.	B1-AS1	B1-AS2	B2-AS1	B3-AS1	B4-AS1	B5-AS1	B5-AS2	B6-AS1	B6-AS2	B7-AS1	B8-AS1
Depth (ft)	1-3.0'	4-6.0'	1-3.0'	1-3.0'	1-3.0'	1-3.0'	4-6.0'	4.5-5.0'	0.0-0.5'	0.0-0.5'	0.0-0.5'
Sample Type	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL
Date	5/21/90	5/21/90	5/21/90	5/21/90	5/21/90	5/21/90	5/21/90	5/22/90	5/22/90	5/22/90	5/22/90
2-PROPANONE	.065	--	--	--	--	--	.03	--	--	--	--
BENZENES	16.22	1.3	24	20	1.1	--	--	22	299	136.9	.48
1H-IDENE,2,3-DIHYDRO	280	32	190	200	--	--	--	250	540	--	7.3
BENZOFURAN	18	1.7	--	--	--	--	--	7.7	--	12	--
UNKNOWN	--	.16	--	3.9	.636	2.3	--	3.2	--	--	--
2-HEXANE,2,5 DIMETHYL	--	--	3.9	--	--	--	--	--	--	--	--
CYCLOHEXANE	--	--	3.5	--	--	--	--	--	--	--	--
CYCLOPENTANE	--	--	4.8	--	--	--	--	--	--	--	--
NAPHTHALENE	--	--	1,100	--	--	--	--	--	--	--	--
4-CARENE	--	--	--	--	2.1	--	--	--	--	--	--
1,3,6-OCTATRIENE, - 3,7-DIMETHYL	--	--	--	--	--	--	--	2.1	--	--	--
BENZALDEHYDE,4-METHYL	--	--	--	--	--	--	--	--	--	--	1.1
TOTAL	314.29	35.16	1326.2	223.9	3.8	2.3	.03	285	839	148.9	8.88

All results reported in Parts Per Million (PPM)

TABLE 4  
FROLA PROPERTY  
Summary of Laboratory Analytical Data - Accutest  
Base Neutral + Petroleum Hydrocarbon Analysis of Soils  
May, 1990

Sample No.	B1 AS1	B1 AS2	B2-AS1	B3 AS1	B4 AS1	B5 AS1	B5 AS2
Depth (ft)	1-3.0'	4-6.0'	1-3.0'	1-3.0'	1-3.0'	1-3.0'	4-6.0'
Sample Type	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL
Date	5/21/90	5/21/90	5/21/90	5/21/90	5/21/90	5/21/90	5/21/90
ACENAPHTHENE	170	67	150	31	ND	.97 J	17
ACENAPHTHYLENE	13	4.7 J	9.6 J	ND	ND	ND	ND
ANTHRACENE	85	36	170	60	ND	1.1 J	19
BENZO (A) ANTHRACENE	29	20	150	180	3 J	4.3 J	67
BENZO (A) PYRENE	20	14	140	210	ND	4.5 J	64
BENZO (B) FLUORANTHENE	15	11	120	190	3.5 J	4.8 J	70
BENZO (K) FLUORANTHENE	18	13	110	160	4.3 J	3.6 J	56
BENZO (G,H,I) PERYLENE	ND	6.5	72	150	ND	3.2 J	40
BIS (2-ETHYLHEXYL) PHTHALATE	ND	.7 JB	17 JB	1.7 JB	ND	ND	ND
CHRYSENE	29	20	160	200	4.4 J	4.9 J	78
DIBENZO (A,H) ANTHRACENE	ND	1.8 J	ND	56	ND	ND	22
FLUORANTHENE	130	71	330	310	7 J	7.9	93
FLUORENE	130	53	170	26	ND	.86	16
INDENO (1,2,3,-CD) PYRENE	7.6 J	6.2	67	140	ND	2.8 J	ND
NAPHTHALENE	520	180	330	16	ND	1.6 J	8.7 J
PHENANTHRENE	200	160	410	150	4.9 J	5.9	66
PYRENE	89	50	270	140	6.7 J	4.9 J	83
	-----	-----	-----	-----	-----	-----	-----
TOTAL BASE NEUTRALS (BN)	1,448	707.7	2,649	2,019	ND	14.7	691
	7.6 J	6.5 J	9.6 J	ND	33.8 J	36.7 J	8.7 J
TOTAL ACID EXTRACTABLES (AE)	8.1	4.7	ND	ND	ND	ND	ND
TOTAL TI SEMI VOLATILES (estimated)	837	3,079	1,397	600	200	109	5,081
TPHC	1,300	710	38,000	11,000	6,000	390	550

All results reported in Parts Per Million (PPM)

TI: Tentatively Identified

ND: Not Detected At Method Detection Limit

B: Indicates compound found in blank as well as sample.

J: Indicates an estimated value below MDL.

NJDEP ECRA Guidelines - BN = 10 ppm; AE = 10 ppm



TABLE 4 (CON'T)  
FROLA PROPERTY  
Summary of Laboratory Analytical Data - Accutest  
Base Neutral + Petroleum Hydrocarbon Analysis of Soils  
May, 1990

Sample No.	B6-AS1	B6 AS2	B7-AS1	B8 AS1	FB-1	FB-2
Depth (ft)	1-3.0'	4-6.0'	1-3.0'	1-3.0'	--	--
Sample Type	SOIL	SOIL	SOIL	SOIL	WATER	WATER
Date	5/22/90	5/22/90	5/22/90	5/22/90	5/21/90	5/22/90
<hr/>						
ACENAPHTHENE	540	240	240	75	ND	ND
ACENAPHTHYLENE	130	57	82 J	ND	ND	ND
ANTHRACENE	560	250	720	12 J	ND	ND
BENZO (A) ANTHRACENE	290	180	240	15 J	ND	ND
BENZO (A) PYRENE	130	110	200	27	ND	ND
BENZO (B) FLUORANTHENE	110	87	180 J	17 J	ND	ND
BENZO (K) FLUORANTHENE	150	85	180 J	8.9 J	ND	ND
BENZO (G,H,I) PERYLENE	39 J	41	74 J	15 J	ND	ND
BIS (2-ETHYLHEXYL) PHTHALATE	ND	ND	ND	ND	ND	ND
CHRYSENE	380	160	330	26	ND	ND
DIBENZO (A,H) ANTHRACENE	19 J	19 J	27 J	5.9 J	ND	ND
FLUORANTHENE	730	420	540	35	ND	1.6 J
FLUORENE	ND	270	530	43	ND	ND
INDENO (1,2,3,-CD) PYRENE	42 J	42	80 J	9.4	ND	ND
NAPHTHALENE	1400	1200	970	120	ND	1.8 J
PHENANTHRENE	1000	840	940	55	ND	2.8 J
PYRENE	750	260	890	92	ND	ND
<hr/>						
TOTAL BASE NEUTRALS (BN)	6170	4,242	5,600	473	ND	ND
	100 J	19 J	623 J	83.2 J	ND	6.2 J
<hr/>						
TOTAL ACID EXTRACTABLES (AE)	42	53	ND	ND	ND	ND
<hr/>						
TOTAL TI SEMI VOLATILES (estimated)	4,971	6,300	1,856	437	ND	ND
<hr/>						
TPHC	12,000	3,200	110	37,000	ND	ND

ALL results reported in Parts Per Million (PPM)  
TI: Tentatively Identified  
ND: Not Detected At Method Detection Limit

B: Indicates compound found in blank as well as sample  
J: Indicates an estimated value below MDL  
NJDEP ECRA Guidelines - BN = 10 ppm; AE = 10 ppm

**FROLA PROPERTY**  
**USEPA SOIL SAMPLING DATA SUMMARY**  
**BASE NEUTRAL ORGANICS (BN) AND TOTAL PETROLEUM HYDROCARBON (TPHC) ANALYSES**  
**March 26, 1992**

Sample Number	QE001	QE002	QE003	QE004	QE005	QE009	QE010	QE011	QE013
Sample Type	Soil	Soil	Soil	Soil	Soil	Sediment	Soil	Soil	Water
Acenaphthene	220J	1,000	2,400	280	54J	15J	400	ND	ND
Anthracene	980	ND	1,500	230	140	18J	390	ND	ND
Benzo (A) Anthracene	980	1,100	790J	300	280	41	420	2J	ND
Benzo (A) Pyrene	1,100	1,100	ND	260	250	ND	340	ND	ND
Benzo (B) Fluoranthene	1,100	1,100	ND	230	300	29	260	ND	ND
Benzo (K) Fluoranthene	ND	940J	ND	230	320	32	ND	ND	ND
Benzo (G,H,I) Perylene	ND	520J	ND	ND	ND	ND	ND	ND	ND
Bis (2-Ethylhexyl) Phthalate	ND	ND	ND	ND	ND	9J	ND	ND	ND
2-Methylnaphthalene	ND	670	4,200	230	ND	12J	340	ND	ND
Chrysene	1,100	1,400	850J	290	360	35	420	ND	ND
Acenaphthylene	ND	ND	ND	26J	ND	ND	39J	ND	ND
Di-N-Butyl Phthalate	ND	ND	ND	ND	22J	65	24J	17	ND
Di-N-Octyl Phthalate	ND	ND	ND	ND	ND	12J	ND	ND	ND
Fluoranthene	2,300	4,700	2,600	930	540	94	1,200	3	ND
Fluorene	310J	1,000	2,100	300	44J	18J	460	ND	ND
Indeno (1,2,3-CD) Pyrene	ND	640J	ND	ND	ND	ND	ND	ND	ND
Dibenzofuran	ND	720J	2,100	200	40J	ND	280	ND	ND
Naphthalene	170	920J	13,000	490	ND	21J	800	ND	ND
Phenanthrene	1,700	4,900	5,500	930	300	82	1,400	4J	ND
Pyrene	2,700	3,600	3,400	1,200	560	110	2,300	7	ND
Total BN Organics	12,130	20,570	31,850	6,100	3,050	488	9,010	27	ND
Total TI BN Organics	NA	NA	NA	NA	NA	NA	NA	NA	NA
TPHC	440	15,000	8,000	15,000	160	490	12,000	ND	ND

All results reported in Parts Per Million (PPM)

TI = Tentatively Identified

E = Estimated Value; Value exceeds instrument calibration range

J = Estimated Value

ND = Not Detected at Method Detection Limit

NA = Not Analyzed

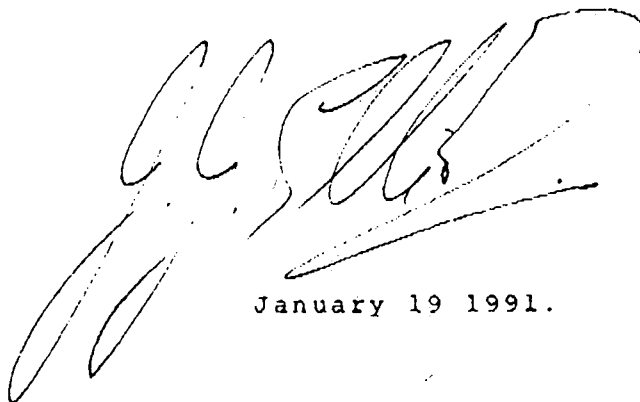
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**APPENDIX B**  
**REPORTS BY DR. JAMES J. ELLIOT**

JAMES J. ELLIOTT & ASSOCIATES, INC.  
CONSULTING CHEMISTS

Report on the Probable Sources of Contamination  
on the Froila Property at 163, River Road,  
Edgewater, New Jersey.

J. J. Elliott.

A large, stylized handwritten signature in black ink, likely belonging to J. J. Elliott, is positioned above the date. The signature is fluid and cursive, with a long horizontal stroke at the bottom.

January 19 1991.

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Composition of Petroleum and Coal-tars	Page 4
Discussion of Analytical Results	Page 7
Conclusions	Page 12

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## INTRODUCTION

The author of this report was asked to review analytical data obtained on soil samples taken at the Frola property in Edgewater, New Jersey. The data were summaries of results obtained by standard analytical methods on soil samples from eight (8) borings on the site. These borings were identified as B-1 through B-8. Most of the borings covered the top 1 to 3 feet of the property; some went deeper. A map of the sampling locations was provided. The data included the following types of information.

Total Petroleum Hydrocarbons (TPH)

Volatile Organic Compounds (VOC)

Base Neutrals, by Extraction GC/MS (TBN)

Tentatively Identified Semi-Volatiles (TISV)

The analyses had been carried out by Accutest, of Dayton, NJ and were provided by Paulus, Sokolowski & Sartor, Consulting Engineers, of Warren, NJ. Copies of the gas-chromatograms and the subsequent mass-spectra were provided for samples B-1 and B-3. Drilling logs were also provided.

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The data were reviewed to see whether they could provide information as to the probable source of the observed soil contamination; in particular, whether the contaminants were derived from coal-tars, petroleum derivatives, or both.

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The Composition of Petroleum and Coal Tars

Before discussing the analytical results and their interpretation in terms of the probable source of the contamination, it seems imperative to discuss the basic chemical differences between coal- and petroleum-derived materials. There are, in general, major compositional differences between coal- and petroleum-derived fluids, caused partly by the very different chemical composition of the raw materials; coal or petroleum; and partly by the processes by which the fluids are formed; thermal decomposition or distillation.

Coal is an organic solid, containing predominantly the element carbon, along with high concentrations of the elements hydrogen, oxygen, nitrogen and, to a lesser degree, sulfur. Coal also contains mineral matter, frequently including the mineral iron sulfide. When coal is pyrolysed; heated; it decomposes to form gases, coal tars and coke. The tars are very aromatic in composition. They are rich in naphthalenes in particular, along with anthracenes and other polynuclears. They are also rich in phenolics, which contain much of the original oxygen, and nitrogen heterocyclics such as pyridines and quinolines. The initially-formed tars can be distilled into light naphthas; very rich in benzene, toluene and xylenes; into creosotes; rich in naphthalenes; into anthracene oils and into residue pitch. The



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phenolics and nitrogen-containing compounds are frequently removed from the tars because of their value as chemicals. The various cuts can be treated in various ways to improve their properties for a given usage; heat-soaked, air-blown etc; but the basic, highly aromatic nature of the products remains unchanged.

Petroleum on the other hand is essentially a liquid; rich in carbon, to a lesser degree in hydrogen but low in nitrogen and very low in oxygen. Products are initially produced primarily by distillation and are rich in the compound types called paraffins and cycloparaffins (naphthenes) rather than aromatics. Petroleum products do contain aromatics, but they are more likely to be combined with naphthenes than to be bare or lightly-substituted as in coal-derived products. Thus a major way of determining the probable source of a given "oily material" is to look at the aromaticity, both amount and type, and to look particularly at the naphthalene content. It should be noted that "naphthalenes" and "naphthenes" are quite different materials despite the unfortunate similarity in names.

A second way to determine probable origin is to compare the numbers obtained by the analyses for TPH and TBN, two separate analytical procedures. In a way, this is also a measure of aromaticity. In essence, petroleum-derived material will tend to give high TPH and low TBN, whereas coal tars will tend to give TBN's that are higher than the TPH value.

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There are other "markers" that can be looked for, in themselves not necessarily definitive, but in combination can provide supportive information. One marker is the phenolic content, often high in coal tars, always low in petroleum. Benzofurans are often found in coal tars, rarely to any significant extent in petroleum. Petroleum is rich in paraffins and cycloparaffins (naphthenes), coal tars are always low.

Odor is often used to suggest the presence of petroleum products in soils and water. However, this is less definitive when coal tars are also a possibility. The odors are easily confused, today many people may have never smelled or have forgotten the odor of coal tar, whereas petroleum products are common. Further, whereas light-oils and creosote have strong odors, cold pitch, a solid, may have little or none.

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Discussion of Analytical Results

Sample B-1, AS.1, Lab #E012766, from a depth of 1 to 3'.

The boring log describes the sample as "Dark grey-black sand and gravel, with cinder material. Residual sheen/product. Petroleum odor."

The analytical data includes:

Total Phenolics	16ppm
TPH	1300ppm
VOC	54ppm
TIVOC	314ppm
TBN	1448ppm)
TISV	837ppm ) 2285ppm

The raw TBN data shows 520ppm of naphthalene, about 30% of the TBN, a very large proportion. The sample is also rich in other low molecular weight aromatics: phenanthrene, acenaphthene and fluorene; less so in the larger benzo-aromatics. The total of the identified and TI semi-volatiles, 2285ppm, is considerably larger than the value for TPH, suggesting that the contaminant is highly, but not totally, aromatic. It is probable that the contaminant is a mixture of creosote oil with some petroleum-derived oil. Compared to the other samples, the phenolic content and the VOC content is average, also suggesting a mixture.

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It is of interest to look at the compounds that are "tentatively identified", TI. It is difficult to identify each and every peak in the GC chromatograms of complex mixtures such as these samples. Sometimes, the compound is simply not in the library. More frequently, the peak does not represent a single, pure component, but a mixture. The mass spectrum is thus complicated, several options are available and a certain degree of uncertainty prevails. However, one can look at all of the suggested TI's for a number of peaks to see if a pattern appears. It is necessary though to do a little logical editing of the data. The computer program that does the TI's attempts to match the mass spectrum with some 30,000 reference spectra, most of which have no association with coal or petroleum. Many of the TI's are compounds that would degrade in the environment from which these samples came; they would oxidize in the sun and air. Others are water-soluble and would long ago have dissolved in rainwater and disappeared. Most however are such complex organic chemicals that one would be hard pressed to explain their occurrence on this site. The TI's are just a statistical match of data sets; it seems appropriate to look over the suggested alternatives for each TI to see what makes most sense with the known history of the site. When one does this, a pattern does immediately become apparent for this sample. The compounds seem mostly to be small mono-, di- and tri-substituted naphthalenes, along with other small aromatics. TI's 5 and 7 are given the same ID by the computer; this cannot be. More likely they are methylnaphthalene isomers. This would

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be consistent with the high naphthalene content. TI 15, dibenzofuran, is very important, along with TI 21, its methyl homolog. As previously stated, dibenzofuran is not found to any significant degree in petroleum. It is in coal tars.

The combination of the TI's along with the knowns reaffirms that the contamination in this portion of soil is probably a mixture of coal tar and petroleum-derived material, probably higher in coal tar.

Sample B-3, AS.1, Lab #E012769, from a depth of 1 - 3'.

The boring log describes the sample as " 6" grey-black silty sand, 6" black coal-tar cinders with trace silt (some brick fragments). Petroleum odor."

The analytical data includes:

Total Phenolics	75ppm
TPH	11000ppm
VOC	68ppm
TIVOC	224ppm
TBN	2019ppm)
TISV	600ppm ) 2619 ppm

The raw TBN data shows only 16ppm of naphthalene, a very small proportion of the TBN. Rather, 50% or more of the TBN is pyrene and larger polynuclear aromatics. Further, the TPH is some

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four times that of the TBN. By the logic previously described, the TI's again fall into a class, but, unlike B-1, the class is predominantly paraffins and naphthenes. This suggests that that in this instance, the contaminant is predominantly petroleum-derived. The bias of the aromatics to the heavy end suggests that the coal-derived portion is pitch rather than a creosote, consistent with the log description.

By the same logic used for the previous two samples one can make general statements about the probable cause of the contamination for the remaining samples for which the data was in summary form.

B-1, AS.2, 4 to 6'. Probably mixed creosote/petroleum.

B-2, AS.1, 1 to 3'. The TPH is 38000ppm, 3.8%, extremely high. The contamination is predominantly petroleum with some creosote/naphthalene.

B-4, AS.1, 1 to 3 '. Essentially all petroleum derived.

B-5, AS.1, 1 to 3'. Overall contamination is lower than most and is probably mostly petroleum-derived.

B-5, AS.2, 4 to 6'. The TBN at this level is much higher than for the upper level and is probably coal tar.

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B-6, AS.1, 1 to 3'. Petroleum, creosote and pitch.

B-6, AS.2, 4 to 6'. Similar to the upper level, with less petroleum.

B-7, AS.1, 1 to 3'. Essentially all coal-derived, both creosote and pitch. The phenolics are very high by comparison, possibly phenol itself is a third component.

B-8, AS.1, 1 to 3'. Almost entirely petroleum-derived and at a high level.

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Conclusions

The analytical data show that the site is contaminated with both coal tars and petroleum-derived materials. The coal-derived material includes both creosotes and pitch. The relative proportion of the coal tars and petroleum-derived materials varies markedly around the site, ranging from predominantly one or the other to varying mixtures of both.



JAMES J. ELLIOTT & ASSOCIATES, INC.  
CONSULTING CHEMISTS

Report on the EPA data from the  
Frola Property

J. J. Elliott.

January 9, 1994

## INTRODUCTION

In a previous report (1) I reviewed analytical data obtained on soil samples from the Frola property. That report contained a short review covering the compositional differences expected between coal and petroleum-derived fluids.. In summary, coal-derived fluids are highly aromatic, containing high levels of Polynuclear Aromatic Hydrocarbons (PNA's). Petroleum-derived fluids on the other hand are predominantly aliphatic, with very low levels of PNA's.

Two key analyses for distinguishing between coal and petroleum-derived fluids are the aromatic compounds (PNA,s) measured as priority pollutants in the "Total Base Neutrals"; TBN; analysis and the "Total Petroleum Hydrocarbon"; TPH; analysis.

The TBN analysis gives the concentration of unsubstituted PNA's, markers for coal fluids. The analysis does NOT measure the concentration of the substituted aromatics, the methyl (except methyl naphthalene), dimethyl, ethyl etc. Thus, summing the concentrations of the measured PNA's only puts a lower limit on the concentration of coal fluids. The TPH analysis on the other hand gives the maximum amount of petroleum hydrocarbon present. However, in the circumstances that exist on the Frola property, where coal fluids appear ubiquitous, I have a concern that the high levels of PNA's as measured by the TBN analysis may interfere with the Polynuclear Aromatic Hydrocarbon analysis and result in answers that are too high. I will return to this concern in the conclusions/recommendations section.

## DISCUSSION.

The samples taken by the EPA; 5 soil, 1 sediment and 1 water; were analysed by Upstate Laboratories, Inc, in March 1992. The comments that follow on the TPH contents are subject to the caveat that some values may possibly be artificially high.

### Soil #1.

The TPH is 440 ppm, the PNA content is greater than 20,000 ppm. The material in the soil is predominantly, probably greater than 95%, coal fluids.

### Soil #2.

The TPH is 15,000 ppm, the PNA content greater than 20,000 ppm. The material in the soil is mostly coal fluids, though there could be some

petroleum-derived material present also. Lead is reported at 2100 ppm and a potential source for this is from leaded gasoline. However, the benzene, toluene and xylene content is very low; 2 ppm; suggesting that the lead is not from leaded gasoline. Arachlor 1242 is reported in this sample, the only time to my knowledge that it is reported in any sample from the Frola property. In view of the very high aromaticity of the organics in this sample it may be worthwhile taking a second look at the raw data for this analysis to be sure that there is no interference.

Soil #3.

The sample has 8,000 ppm TPH, greater than 17,000 ppm of PNA's, together with an additional 17,000 ppm of naphthalene and methyl naphthalene. In addition, it contains some 2,000 ppm of dibenzofuran, a compound type found in coal fluids but rarely, if ever, found in petroleum. The material in the soil is predominantly a coal fluid, probably greater than 85%. The large amount of naphthalene suggests a naphthalene spill.

Soil #4.

The analysis was done in duplicate. The soil has 15,000 ppm (12,000 ppm) of TPH, and around 5,000 ppm (7,000 ppm) of PNA's. The sample contains coal fluids and probably some petroleum-derived material.

Soil #5.

The soil contains 160 ppm TPH and about 2,600 ppm of PNA's. The soil contains predominantly coal fluids, probably greater than 95%.

Sample #9; sediment.

The sample contains 490 ppm PHC and about 400 ppm PNA's. The sample contains coal fluids and probably some petroleum-derived material. Considering that the sample is a river sediment, it would be useful to compare this analysis to an analysis of sediment found upstream of the property before concluding that the property is necessarily the source of the contamination, particularly of the TPH.

Sample #8; water.

The sample contains 4 ppm of TPH and about 230 ppb of PNA's. The water probably does contain a low level of coal fluids and probably some petroleum. Again, the numbers should be compared to values found upstream (and downstream if tidal) from the property.

## CONCLUSIONS AND RECOMMENDATIONS

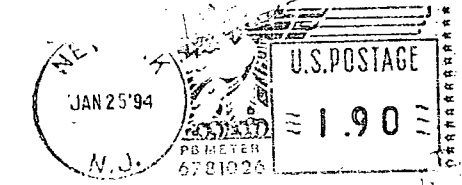
All the samples show the presence of coal-derived material. Some of the amounts are substantial considering that the TBN analysis is only measuring bare-ring PNA's and not the substituted ones.

I have some concern about the validity of the TPH values and whether or not they are biased high by the presence of such large amounts of non-petroleum organics. One step in the TPH analysis requires that an extract of the sample be treated with activated silica gel to remove non-petroleum organics. If, because of the unusually large quantities of non-petroleum material found in some of these samples insufficient gel was used, then the answers could be biased high. I would recommend that for future analyses for TPH that a variation of the method be invoked, a variation that the extract be treated a second time with activated gel and the measurement repeated. An unchanged value would show that an adequate amount of gel had been used first time, a changed value would show that insufficient gel had been used. Considerable care must be taken during this second treatment, for the solvent used for this analysis, FREON 113, is very volatile and readily lost, leading to incorrect results, biased high. I would also recommend that the infrared finishing step to this analysis be carried out on a scanning spectrometer, between 3400 and 2600 cm<sup>-1</sup>, rather than on the customary filter system. Such a scan would provide a fingerprint of the extracted material that can then be compared to the fingerprint of the calibrating standard. The spectra of coal fluids over this region are very different to the spectra of petroleum liquids.

When the sampling points covered by my first report are compared with those covered here, two of them; #1 of the EPA and B4 for the first report; seem from the maps to be very close together. The PNA values however are very different. The first set of data shows "none detected", the EPA data reports about 12,000 ppm, 1.2%. The large difference between these two values, coupled with the fact that the EPA reports more PNA's in their samples than were found in the earlier samples (different sampling sites), shows that coal fluids are widely found on the property, sometimes at high levels, and sometimes highly localized.

(1) Report on the Probable Sources of Contamination on the Frola Property. January 19, 1991.

12983-1



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